Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

SHOUT
SHARE
IT

BULLETIN OF THE
U.S. DEPARTMENT OF AGRICULTURE

No. 211

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.
May 26, 1915.

FACTORS AFFECTING RANGE MANAGEMENT IN NEW MEXICO.

By E. O. Wooton,
Agriculturist, Office of Farm Management.

CONTENTS.

	Page.		Page.
Introduction	1	Nature of the forage crop and its distribution	20
The topography of New Mexico	2	Undesirable range plants	23
Climate	3	Erosion	25
Soils	7	Range management	26
Subdivisions of the land	8	Character of the present opposition to control	37
Relative importance of stock raising	10	Summary	37
Legal status of the business	15		

INTRODUCTION.

Stock raising is more patently influenced by and dependent upon its physical environment than most other industries appear to be. The topographic and climatic conditions are fundamental, because they determine the kind and quantity of feed the animals must eat, the temperature and other extremes they must endure, and the various dangers which they must avoid.

The laws and customs of the region determine the character of the tenure and control of the land which produces the feed upon which the animals subsist. They are but the expression of the public opinion that warrants the existence of that industry in that place. And not less important, but probably less often considered, is the relation which the business bears to other industries in operation in the same region. From this standpoint, the industry is to be considered as in a certain stage of development toward a better and more complex adjustment among all industries, and a statement of its present condition must be taken as in the nature of a report of progress. It is not what it once was, nor yet what it will be. Thus, while we are

Note.—The various factors influencing the live-stock industry in New Mexico, especially as affecting range management, are presented and discussed in this bulletin.

84972°—Bull. 211—15——1

here mainly concerned with the details of the purely physical basis of the industry, the factors of control and relation to other industries are so closely connected with any proper kind of management that they must be considered somewhat at length; and a study of range conditions is but preliminary to an understanding of methods of management and the requirements necessary for the further improvement of the industry.

THE TOPOGRAPHY OF NEW MEXICO.

New Mexico is almost square in outline, being about 350 miles long from north to south, nearly as wide at the southern end, and somewhat narrower along the northern boundary. Only the southern boundary is a broken line. The State consists essentially of a high, arched plateau, the axis of the arch being near the middle and running north and south, the northern end being higher than the southern. This plateau is about 7,000 feet above sea level at its highest point on the northern boundary line and drops to about 3,500 feet at its southern end.

Apparently resting upon this plateau, which is but a part of the great Rocky Mountain uplift, are numerous mountain ranges that seem to rise out of the sweeping plains as islands from the sea. These mountains are of two fairly well-defined types—narrow, rocky ridges, with but a scanty covering of low bushes and scattering trees, and great mountain masses, consisting of numerous associated ridges more or less densely covered with forests and woodland. Nearly all the main ranges have a northerly and southerly trend. Some of the mountains are composed of granites, rhyolites, gneisses, and other igneous and metamorphic rocks, while many of them are great monoclinal piles of tilted, stratified rocks with sharp escarpment faces upon one side. In actual altitude they range from less than 5,000 feet to more than 14,000 feet, there being numerous peaks and ranges over 10,000 feet high.

Large lava flows have occurred in several places, resulting in sheets of black, vesicular basalt, covering extensive areas. Associated with these flows are several large, extinct volcanoes and numerous small cones. The lava sheets have done much to modify the relief features, since the lava (or mal pais, as it is locally known) is harder than the underlying rocks and protects them from erosion. This has resulted in a number of high mesas and buttes that almost take on the dimensions of mountains. (Pl. I, fig. 1.)

The wide stretches of seemingly level plains that lie between the mountain ranges are nowhere really level. Many of them are typical bolsons, or basins, into which drains all the water that falls in the region. These bolsons are independent of each other and may occur at any altitude (Pl. I, fig. 2). The San Augustine Plains in central

Socorro County and the Estancia Valley in Torrance County are typical examples. These plains are everywhere dissected by dry watercourses, or arroyos, which serve to collect the flood waters that are sometimes temporarily very abundant, and sheet erosion of unprotected soil surfaces is everywhere very rapid, largely because of the steep gradient of even that part of the surface, which, by comparison with the bolder relief features, seems to be level. Many of the striking topographic features, both of sculpture and deposition, are due to wind action. On the eastern side of the State the mountains and mesas gradually subside into the wide expanse of the Staked Plains, while to the west Arizona is but a repetition of the alternation of plains and mountains so characteristic of New Mexico but at a slightly lower general level.

The river valleys are narrow and not infrequently constricted to the river channels alone or "boxed in" where they cut through mountains or mesas. The two largest rivers, the Rio Grande and Rio Pecos, run entirely or almost across the State from north to south. The San Juan and the Gila flow out of the State westwardly in San Juan and Grant Counties, respectively, while the northeastern part of the State contains some of the tributaries of the Arkansas River and the headwaters of the Canadian, all of which flow eastwardly. The most conspicuous feature of all these streams is the small number of permanent tributaries possessed by each when the size of its drainage area is considered. The valley bottoms throughout the State, wherever there is a permanent flow of water, are always turned into cultivated fields, and many acres of such lands produce alfalfa. (Pl. II, fig. 2.)

CLIMATE.

Precipitation.—Precipitation is everywhere relatively small in amount in New Mexico. On the plains of the southern part of the State and in all of the river valleys outside of the mountains it is always scanty. In the mountains at altitudes of 5,500 feet or more it is more abundant, but even in the more moist regions the amount of water that falls during the year is rarely equal to that which is common in the humid regions farther east.

To say that there is a summer rainy season does not mean what the same expression tells in regard to a tropical country. It merely says that most of the rain of the year comes during July, August, and September, and that this is the growing season on the plains and almost everywhere in the mountains. In some of the higher mountains, where there is considerable snow during the winter, the ground is left wet enough by the melting of these snows to cause a certain spring and early-summer growth; and some of the perennials of even the drier plains put out their blossoms and grow some new leaves in May

and June each year if there has been a normal rainfall the previous summer. But it is true of practically all of the State that May and June are the driest months of the year, and summer arrives without any heralding by spring. It has been said that there are but two seasons in the southern valleys, summer and late fall, and the longer of these is summer. The summer rains usually occur as rather violent local showers of short duration. The water falls from clouds that are high above the earth, and the air next the ground may be relatively dry; in fact, it is not infrequent to see small, high clouds that are evidently producing some rain, but the water evaporates at a lower level and never reaches the ground. Drizzling rains from low-hung, drifting clouds that roll along only a few hundred feet above the earth are only occasional anywhere except upon the cloud-capped peaks of the high mountains; and heavy general storms moving steadily over large areas are very rare.

A study of the United States Weather Bureau reports indicates that there are two factors fundamental in nature which determine in a general way what the average precipitation of any point in the State shall be. The first of these is the well-known relation between precipitation and altitude, depending upon the effect of forcing currents of moisture-laden warm air to higher atmospheric levels through the upward deflection of such currents by the mountains. It thus happens that, other things being equal, the precipitation increases with altitudinal increase, though not always in a direct ratio.

The average precipitation of any station in the State also seems to be in some way dependent upon its distance from the southeast corner. If localities having the same altitude be considered, it appears that those in the southeastern corner have the greatest average rainfall, and that this rainfall gradually diminishes as one goes west and north. This fact would seem to suggest that the source of the moisture lies to the southeast, possibly the Gulf of Mexico. Local factors enter into the case, sometimes decreasing, sometimes augmenting the amount of precipitation for a particular location. Some of the extreme records for the State follow and will give an idea of the limits of variation. A normal rainfall chart for New Mexico has been published by the State immigration bureau.

The maximum precipitation in the State recorded for any single calendar year is for Elk, 39.1 inches, in 1905. There is possibly some inaccuracy in this record, or the station is subjected to local conditions which tend to increase the normal expectancy for this altitude, 7,400 feet. Cloudcroft (8,650 feet) received 32.32 inches in 1905; Chama (7,851 feet) received 32.83 inches in 1891; and the highest record for Windsor (8,200 feet) is 27.92 inches in 1907. The lowest records occur in the lower valleys. San Marcial (4,439 feet)

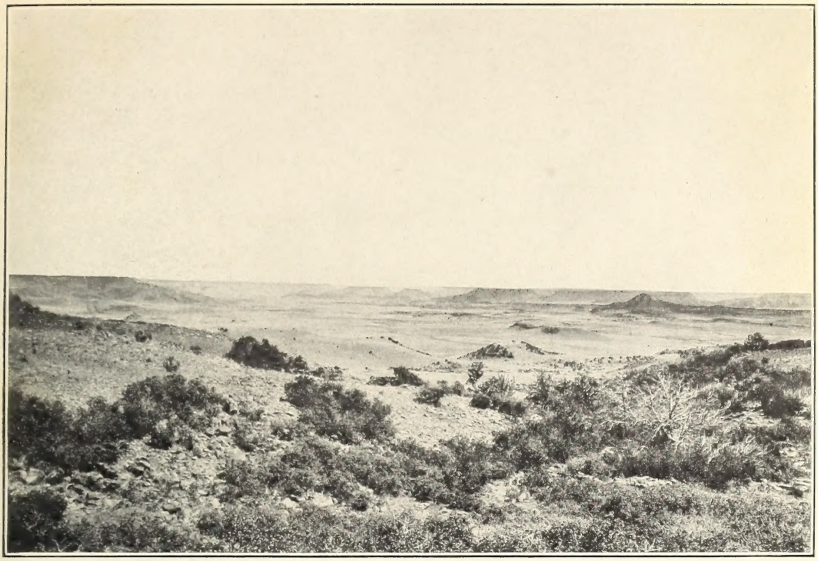

FIG. 1.—VIEW IN THE NORTHEASTERN PART OF NEW MEXICO, SHOWING THE TOPOGRAPHY AS AFFECTED BY LAVA SHEETS.

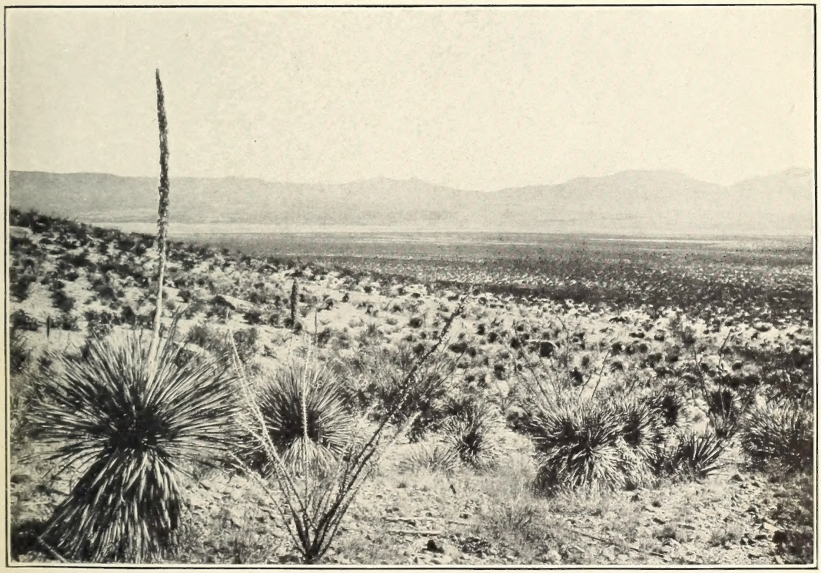

FIG. 2.—A TYPICAL BOLSON, OR BASINLIKE MESA, IN THE SOUTHERN PART OF NEW MEXICO, SHOWING THE SHRUBBY ASSOCIATION ON THE GRAVELLY PORTIONS OF SUCH AN AREA.

FIG. 1.—AN AREA IN NEW MEXICO HAVING A TYPICAL COMPACT GROWTH OF BLUE GRAMA, COMMON ON THE NORTHERN PLAINS.

FIG. 2.—A SMALL VALLEY IN THE NORTHERN PART OF NEW MEXICO, SHOWING IRRIGATED LANDS PRODUCING ALFALFA.

The growth shown in the foreground is typical of the unirrigated land of the region when the range is protected.

received 3.44 inches in 1894; Mesilla Park (3,863 feet) received 3.49 inches in 1873; Deming (4,333 feet) received 3.42 inches in 1910, while the same year Carlsbad (3,120 feet) received only 3.95 inches.

The variation in the amount of precipitation from year to year is also great. An extreme case is shown at Mesilla Park. In a record for this region extending over 47 years, the average rainfall is 8.62 inches. For five of those years the total amount was just about half of the normal supply. Five other years show from one and one-half to nearly two times the average. It will thus be seen that there is a range from the lowest amount recorded, 3.49 inches, to almost five times that amount, 17.09 inches, the highest record. For one period of ten consecutive years the total annual precipitation was each year below the average quoted above, and periods of three to five years in which the annual rainfall is two-thirds of the normal or less have occurred three times within the time for which the observations have been made.

Snow occurs at some time every winter at all points in the State. At the lower levels the occurrence is rare and the quantity that falls is small, nor does it lie long. In the higher mountains of the northern part of the State considerable of the precipitation comes as snow, and in favorable locations it drifts and lies for most of the winter. From such regions stock are excluded for at least part of the year.

Cloudy weather is the exception, and one bright sunshiny day after another is the rule throughout the State.

Temperature.—The most characteristic peculiarity of the temperature and one which applies at all points in the State is the great range which occurs yearly, monthly, and daily. A daily range of 45° F. is not uncommon, and one of 30° or more may be said to be almost the rule. This condition is, of course, due to the altitude and the lack of moisture in the air.

The mean temperatures of different localities are exceedingly misleading when one is considering climate in New Mexico, because they are made up of high maximum and low minimum temperatures. This statement applies to all the means, daily, monthly, and annual. The highest recorded temperature for the State is 113° F. at San Marcial. A summer maximum of over 100° F. is common for many of the stations at the lower altitudes. The higher elevations, of course, have lower temperatures. The absolute minimum temperatures recorded for the different stations range from 4° to −29° F., and there is always a winter season of three months or more anywhere in the State during which one may expect it to freeze any night. This condition would hardly be expected when one considers the latitude alone and is another consequence of high altitude and aridity.

When it is remembered that the months of spring and early summer are usually quite dry, as well as cold at night, the late starting of the native plants is explained. At high elevations the growing season is short, and above 8,500 feet frosts are recorded for almost every month in the year.

Wind motion.—Wind motion is an important climatic factor throughout the State. The air is nearly always dry and frequently very dry, and the wind blows much of the time. The spring is apt to be particularly windy, and the most violent sand storms are usually accompanied by low humidity and consequent rapid evaporation. Many young seedlings are dried out or cut off by the sand during these windstorms, and much damage is done to cultivated crops even in the irrigated fields.

Exposure.—Differences in exposure to the sun's rays, arising from the direction of slope of all hills and mountain sides, cause striking differences in the climate of stations at the same level and near together, with the consequent differences in vegetation. This effect is readily seen when traversing a mountain canyon that runs east or west. The north-facing slope is always occupied by a plant association entirely different from that of the south-facing slope at similar altitudes above the bottom of the canyon.

Vegetation.—Notwithstanding the various unfavorable climatic conditions that plants must be able to endure, there is a covering of vegetation of some kind practically all over the State except locally in spots where the soil is of drifting sand or so alkaline as to kill plants, or on the flat playas that are subject to occasional inundation, or on exposed rocky surfaces where there is little or no soil. This vegetation is frequently very scanty and scattered, often scrubby and spiny, showing in many ways its adaptation to a scanty supply of water. Many of the plants are valueless as forage, but many times more are good for this purpose, and when examined in detail the wonder grows that so many and not so few are usable by stock at one time or another.

"Finally, it is clear that man, whether by reforestation or deforestation, by flooding a desert or by draining a swamp, can produce no important or extended modifications of natural climate. This is governed by factors beyond human control." [1]

There seems to be no doubt of the correctness of this generalization. But it is possible to materially improve or impair the living conditions for humanity in a given region by the management of those industries that man carries on which are dependent upon the adaptation of these industries to the existing climate of that region. The truth of this statement is recognized without question in a humid

[1] Ward, R. de C. Climate . . . p. 363, New York, 1908.

region and accepted as the natural order of things; but it is of vastly more importance in regions of scanty rainfall. Here any kind of management that permits or assists in the waste of water in any way tends in the long run to the desiccation of the region. Hence, any practice that increases the rapidity or amount of superficial run-off or increases the evaporation of water (other than that which passes through the bodies of growing plants) makes for the gradual drying out and increased sterility of the region. These processes are cumulative, and regions that are easily habitable under one kind of treatment may be gradually changed to desert wastes by another procedure which, to the careless observer, does not seem materially different from the first.

SOILS.

Speaking very generally, the soils of most localities in the State have been formed almost in situ by the disintegration of the underlying or near-by rocks and necessarily have the chemical composition arising from the breaking up of these rocks, mechanical or chemical, or both. The soils of the river valleys have been transported considerable distances and the particles assorted to size by the action of the water. They consist mostly of sand or adobe and are uniform in character and depth only for very short distances, because of the great variations in the volume and velocity of the waters of the streams that have deposited them.

The soils of the larger and higher mountains, wherever they occur, are mostly a rather rich loam, due to the nearly complete chemical decomposition of the rocks, and contain considerable humus derived from the vegetation of such regions. The foothills of the mountains are mostly flanked by talus slopes and outwash plains composed of partially disintegrated rock particles of various sizes, forming gravelly ridges and slopes in which proper soil particles constitute only a small part of the volume.

The soils of the plains and bolsons are largely wind-blown sand or loess. In the bottoms of the basins such soils are sometimes deep, but mostly they form only a thin layer.

Wherever the water collects, evaporation goes on rapidly, with a consequent accumulation of the soluble salts of sodium and calcium known as alkali. Alkali often occurs in the river valleys in the soil of terraces whose surfaces are but 2 or 3 feet above the water table, as a result of the concentration of these salts at the surface by evaporation.

The lava-covered areas are in places but bare black rock, with scattered patches of loess or sand in depressions and behind projecting angles. In other places, where the lava is older, the basalt has decomposed to a rich reddish loam, a soil that is recognizedly one of the best.

Outside of the timber-covered mountains, the soils have little or no humus, because the conditions are unfavorable for the production or decomposition of any large amount of vegetable matter.

A characteristic feature of many of the plains is a layer of white, calcareous material, a few to several inches in thickness, lying a foot or so below the surface. This is known as caliche, or hardpan, and is probably a concentration of this material leached from the lower soil layers by an upward movement of the soil water due to prolonged surface evaporation.

SUBDIVISIONS OF THE LAND.

New Mexico contains a little less than 78,500,000 acres of land. According to the Thirteenth Census (1909 data), 11,270,021 acres, or 14.4 per cent of the total area, were included in farms. This designation is quite misleading, as will be seen farther on; it certainly does not mean that that much land is under cultivation.

Of the above-named area, 1,467,191 acres—only 1.9 per cent of the total area of the State and 13 per cent of the area reported as included in farms—were improved land. The same authority states that 35.9 per cent of the farms were irrigated and that these irrigated farms contained 31.5 per cent of the improved land. Irrigation plants then in existence were able to water 644,970 acres, and irrigation projects were then completed or under way that would irrigate 1,102,291 acres.

Newell[1] estimates the total water supply of the State as sufficient to irrigate 4,000,000 acres. The governor's report for 1909–10[2] states that "thorough investigations which have been carried on during the past four years by the engineering department show conclusively that we have no less than 3,000,000 acres which may be reclaimed by practicable diversion, storage, and pumping projects."

The area of farming land has been markedly increased within the past six or seven years by the introduction of the so-called dry-farming methods in the eastern part of the State. Some of the best land of northeastern Eddy and eastern Chaves Counties and considerable of that in Roosevelt, Curry, Quay, Torrance, Guadalupe, San Miguel, Mora, Union, and Colfax Counties has been patented, and some small part of it has been improved. Estimates made by men well acquainted with the development going on in that region place the area of this land under cultivation in 1911 at 417,000 acres, and these estimates are believed to be conservative. The year 1912 saw more of it in cultivation than ever before, but in 1914 the greater part of it was not cultivated and many of the farms were deserted.

It is probable that this change in the method of using this land will ultimately increase the total number of stock grown in the State,

[1] Newell, F. H. Irrigation in the United States, p. 55. New York, 1902.

[2] Curry, George. Report of the Governor of New Mexico to the Secretary of the Interior. [1909]–10, p. 24. Washington, 1910.

after the people have become adjusted to the conditions of the region. No exact data are available as to the total area that may be cultivated in this way, but an estimate by good authorities places it at approximately 15,000,000 acres, which is doubtless large enough to cover all possibilities.

The national forests of the State now contain 9,881,660 [1] acres of more or less densely timber-covered lands, practically all of which is used as grazing land for at least a part of the year.

Large areas are included in the old Spanish land grants, but much of this land is unfenced and is treated as open range. That portion of it which is arable is included in the farming lands previously referred to; the remainder is grazing land of greater or less value.

As an endowment for the public educational, penal, and charitable institutions, several million acres of land have been given to the State by the Federal Government, and these lands are managed by a State commissioner of public lands. Much of this land is leased, and doubtless most of it will be in the not distant future.

Large areas of land (about 4,000,000 acres) were given to some of the transcontinental railroads when they were first built, but considerable of it has been surrendered for lieu-land scrip or sold outright. About one-half of their present holdings of 2,500,000 acres is rented for grazing purposes, but none of it is fenced.

About 5,000,000 acres of land are held in Indian, military, and other Government reservations, not including the national forests. Stock is run on most of this land, sometimes by the Indians themselves, or the land is leased for grazing purposes by the agents in charge.

On July 1, 1913, there were 31,298,621 acres of Government land open for entry in the State of New Mexico, almost all of which is classified as broken or grazing land. It is probably safe to say that 40 per cent of the total area of the State is still Government land, and therefore used without legal right and controlled only by custom. It is also true that many of the State lands and the Mexican grant lands that might be placed under legal control for one reason or another are not so controlled to-day, though this is a continually decreasing area.

A careful analysis of these data shows that but a relatively small part of the State is fitted for the growing of field crops, and it emphasizes the fact that by far the greater part of the total area, under whatever form of tenure it may be held, is grazing land and is likely to remain so, at least until some method of farming with a smaller supply of water is developed.

[1] Apr. 1, 1914. The gross area includes over 1,000,000 acres of alienated lands.

RELATIVE IMPORTANCE OF STOCK RAISING.

Manufacturing in the Territory is still in its infancy. The mining of coal, copper, gold, and silver are of considerable importance, but the principal pursuits are stock raising and agriculture.[1]

It is somewhat difficult to get reliable statistics concerning the relative economic importance of stock raising in New Mexico, because the summaries made in most reports do not have their component factors combined in the same manner and are therefore not comparable. The Territorial and State auditors' annual reports have been compiled from the county assessors' reports and show only the property returned for taxation. This showing is confessedly inaccurate, being always less than the actual facts, especially as to the number of range animals, which are almost never counted, the returns being based upon an estimate. And taxation values are always based upon some percentage less than 100 of the current selling price at the time of making up the returns.

The figures collected by the United States Census Bureau for the Thirteenth Census are, in the opinion of the present State auditor, probably slightly in excess of the actual facts. These figures, however, are perhaps the most accurate of any available, and in so far as they are usable for our present purpose they will constitute our most reliable data. Unfortunately, the system adopted in the grouping of some of the items is not designed to bring out the comparisons we wish to make. This report does not differentiate between the range lands and the agricultural or cultivated lands. All patented lands are referred to as "Land in farms," and the subdivisions "Improved land in farms," "Woodland in farms," and "Other unimproved land in farms" do not assist in separating the areas of land used as actual farming land from the proper range lands.

There is evidently some difference in the classification of the lands given in the census report and the Territorial auditor's report for the same year, 1909, since the latter shows a larger acreage under the heads of grazing and agricultural lands together than all the "Land in farms" as given in the former, and there can be no doubt that the auditor's report is not in excess of the actual taxable acreage, since taxes were assessed on all the lands so listed. There can hardly be any doubt, either, that the group "Land in farms" of the census report is intended to include agricultural and grazing lands, though some of the lands used for grazing may have been reported to the census taker as mineral or timber lands, or part of the proper timber or mineral lands may have been returned as grazing land in the auditor's report in order to benefit by a lower rate of taxation.

Since practically all timber and mineral lands are used as grazing lands and since there is very little opportunity to falsify the returns of land acreage, the figures given in the auditors' reports are probably very close to the truth regarding the division of the patented lands between the grazing and agricultural industries.

[1] United States 13th Census, 1910, v. 9, Manufactures, Reports by States, p. 787. 1912.

In Table I is shown a summary of the number of acres of land, both grazing and agricultural, and the number of domestic animals (omitting swine and fowls) that were returned for taxation in the years 1909, 1910, 1911, 1912, and 1913. In column 3 of this table is shown the report of the Thirteenth Census upon the same subjects, while in column 2 appears the factor by which the auditor's number for 1909 must be multiplied in order to produce the census number for the same item the same year. This column of figures is interesting as showing the correctness of the auditor's generalization that the valuations returned for assessment have been for a number of years scarcely 50 per cent of the actual value of the property.

From this table may be seen the area of patented land used in stock raising [1] and that which is under cultivation in some kind of farm crops. It should be kept in mind that about 5 per cent of the cattle are dairy cows and are on the agricultural lands or in the towns, that probably two-fifths to one-half of the horses are also on the farms or in the towns, as are practically all of the mules, and that nearly all the sheep, goats, and burros are range animals, the number of these animals that are kept on the farms or in the towns being so small a percentage of the whole as to be negligible.

TABLE I.—*Comparison of the reports of the Territorial and State auditors of New Mexico for the last five years with the Thirteenth Census report.*

Land and animals.	Factor.	Thirteenth Census (1909).	1909	1910	1911	1912	1913
Land (acres):							
Grazing	.....	.....	11,180,159	11,218,856	11,572,790	12,654,535	13,686,833
Agricultural	.....	.....	[1] 2,164,952	1,735,776	1,774,049	2,443,875	2,696,426
Farms	.....	11,270,021	[2] 13,345,111	[2] 12,954,111	[2] 13,346,839	[2] 15,098,410	[2] 16,383,259
Live stock (number):							
Cattle (all kinds)	2.48	1,081,663	480,558	390,155	359,308	386,565	570,939
Horses	2.02	171,525	84,847	79,711	74,963	83,936	104,253
Mules	1.69	14,937	8,804	9,239	9,145	9,248	9,638
Burros	2.81	11,853	4,207	4,722	5,146	5,555	5,794
Sheep	2.27	3,346,984	1,472,866	1,368,460	1,280,467	1,463,691	1,693,970
Goats	2.24	412,050	183,872	151,639	133,734	145,165	190,658

[1] To understand why more agricultural land was returned in 1909 than in 1910 and 1911, it is necessary to remember that 1909 was a year of large influx of settlers into the dry-farming area. The next year was dry and many claims were deserted, and much of the land was returned as grazing land after title had been obtained by commuting.

[2] This is the sum of the area of grazing and agricultural lands and is comparable with the Census report figures.

Figures 1, 2, and 3 show the approximate density of distribution of range animals by counties. These charts were prepared from the Thirteenth Census reports and are from enumerations made in 1909.

[1] This takes no account of the large area of State lands leased for grazing, the national forests grazed under a permit system, or the immense area of Government lands used without charge of any kind.

As will be seen by consulting Table I, these figures are greatly in excess of the latest available tax returns (1913), but if the tax returns for 1913 are compared with those for 1909 it will be observed at once that the numbers of different kinds of stock returned for the two years are not very dissimilar. There are some fluctuations in the returns for the different counties, but the general variations are small.

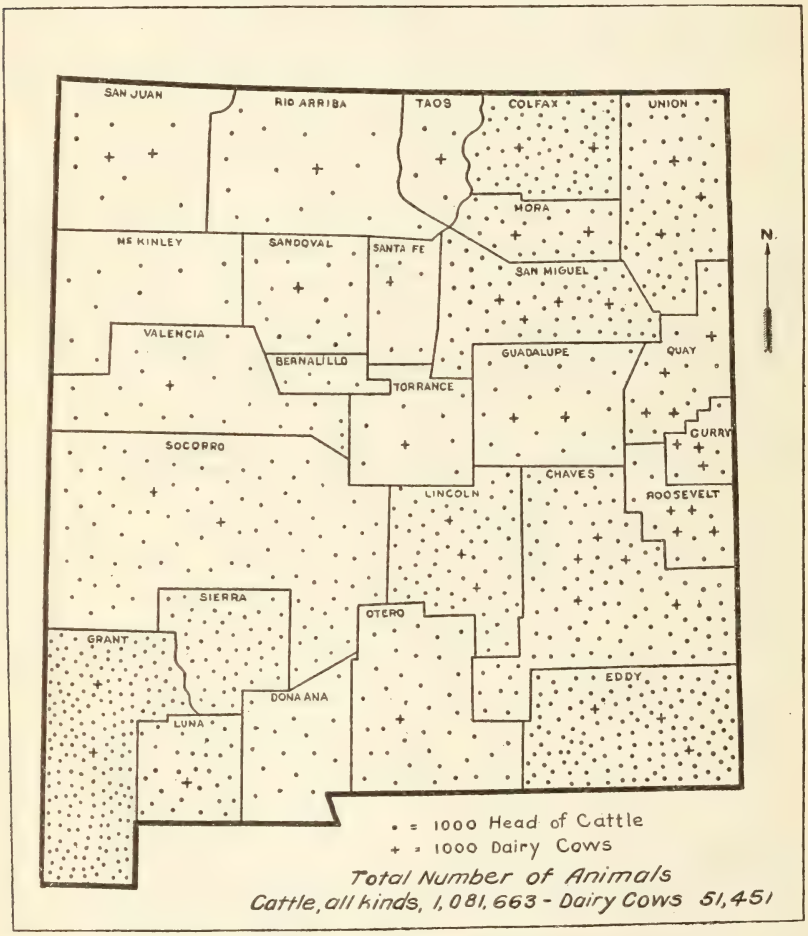

FIG. 1.—Outline map of New Mexico, showing the distribution (by counties) of cattle of all kinds and dairy cows, according to the Thirteenth Census.

The charts show the ordinary geographic distribution and relative importance of each kind of stock as well as it could be presented without assuming much smaller units of area requiring more detailed data. From these diagrams we learn that the central, northern, and northeastern parts of the State are most heavily stocked with sheep, while the southwestern, southeastern, and northeastern corners are more

heavily stocked with cattle. Horses, mules, and burros are about uniformly distributed over the State, and goats occur mainly in the southwest corner and in the north-central part.

Table II shows the percentage of the total valuation which each large group of property represents in the assessment returns. It is

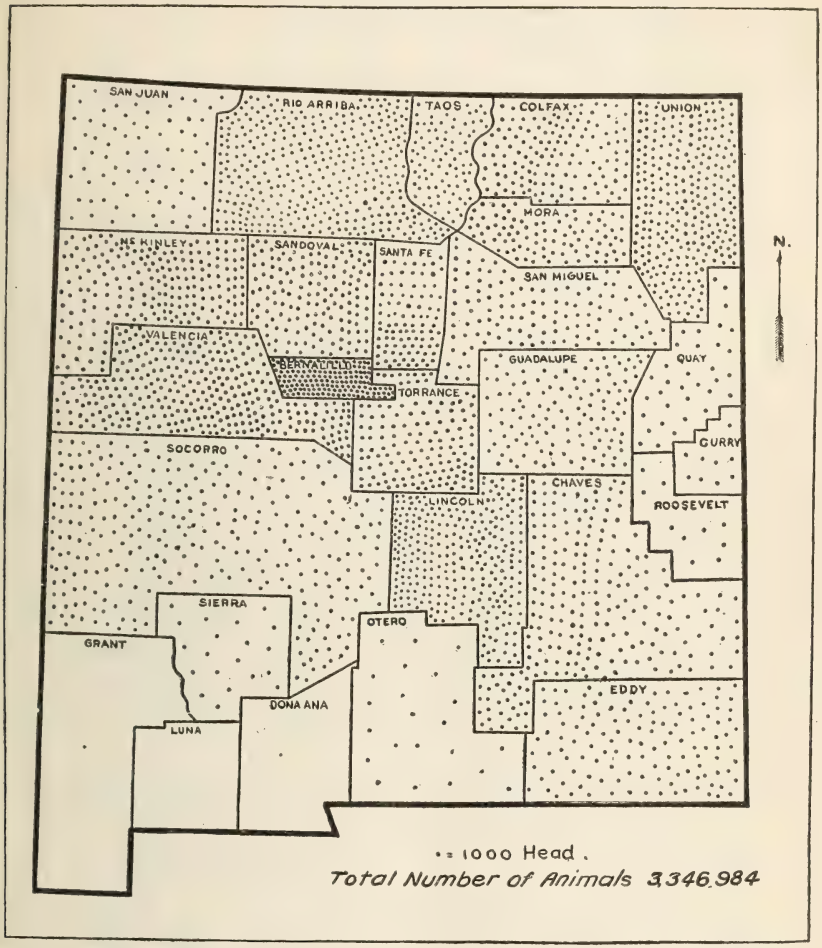

FIG. 2.—Outline map of New Mexico, showing the distribution (by counties) of sheep, according to the Thirteenth Census.

recognized that the valuations ascribed are not correct, but the general reduction in values is so nearly uniform as to make the percentages of valuation represented by each class of property quite accurate. The relative importance of the different classes of property is also indicated.

TABLE II.—*Percentage of the total assessed valuation in New Mexico contributed by each different kind of property.*

[Data taken from Territorial and State auditors' reports.]

Classes of property.	1909	1910	1911	1912	1913
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Railroads	24.218	25.056	24.307	26.460	32.826
City property and improvements	17.621	18.512	18.142	15.929	13.942
Agricultural lands and improvements	12.220	13.444	13.976	14.929	14.275
Grazing lands and improvements	13.383	13.082	14.595	14.238	11.009
Cattle (all kinds)	7.042	5.917	5.392	5.809	7.139
Merchandise	4.683	4,637	4.438	3.733	3.212
Sheep and goats (all kinds)	4.427	4.127	3.847	3.079	2.821
Stocks, bonds, money, public utilities, mills, etc	4.043	3.645	3.729	3.448	3.722
Household goods, musical instruments, watches, clocks, sewing machines, vehicles of all kinds, saddles, harness, farming implements, etc	3.532	3.460	3.370	3.123	2.115
Mineral and timber lands, with all improvements and products	3.434	3.404	3.844	5.090	4.808
Horses, mules, and burros	3.022	2.849	2.622	2.632	2.377
All other property	2.375	1.867	1.738	1.919	1.614

Table III is a grouping of the percentages taken from Table II, which shows approximately what part of the total tax valuation of the property of the State is invested as capital in the business of stock raising. The data available do not permit of an accurate distribution of land area and improvements, stock, and other property so as to show the exact relation of stock raising to agriculture and other forms of industry, but the estimates offered in Table III do show the percentage values of grazing land, improvements, and stock upon the ranges. If the proper percentage of the valuation of vehicles, saddles, harness, farm implements, and household property belonging to and being used in the stock-raising industry be added to the totals given in this table, it will be seen that the business utilizes about one-fourth of the taxable property in the State, to say nothing of the value obtained from the use of public lands.

TABLE III.—*Approximation of the percentage of the assessed valuation of the property of New Mexico that is invested as capital in the stock-raising industry.*

Property.	1909	1910	1911	1912	1913
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Grazing land and improvements	13.383	13.082	14.595	14.238	11.009
Total cattle (less dairy cows = 5 per cent)	6.690	5.621	5.122	5.519	6.782
Total sheep and goats (all kinds)	4.427	4.127	3.847	3.079	2.821
One-half total horses, mules, and burros	1.511	1.424	1.311	1.316	1.188
Total	26.011	24.054	24.875	24.152	21.800

Judged as an industry by the capital invested in the business, stock raising stands second in importance to the railroads only, and it has reached this status but recently, partly by a marked increase in the valuation of the railroad property for taxation by the assessor. It is directly comparable on the same basis to farming as an industry, which it surpasses slightly. It very noticeably exceeds in taxable

valuation all the city and town property of the State; and when we take into consideration that it is a productive business, continually bringing into existence new wealth and not merely shifting value from one holder to another, the importance of the industry is still more apparent and it becomes at once one of the most important industries, if not the most important industry, of the State.

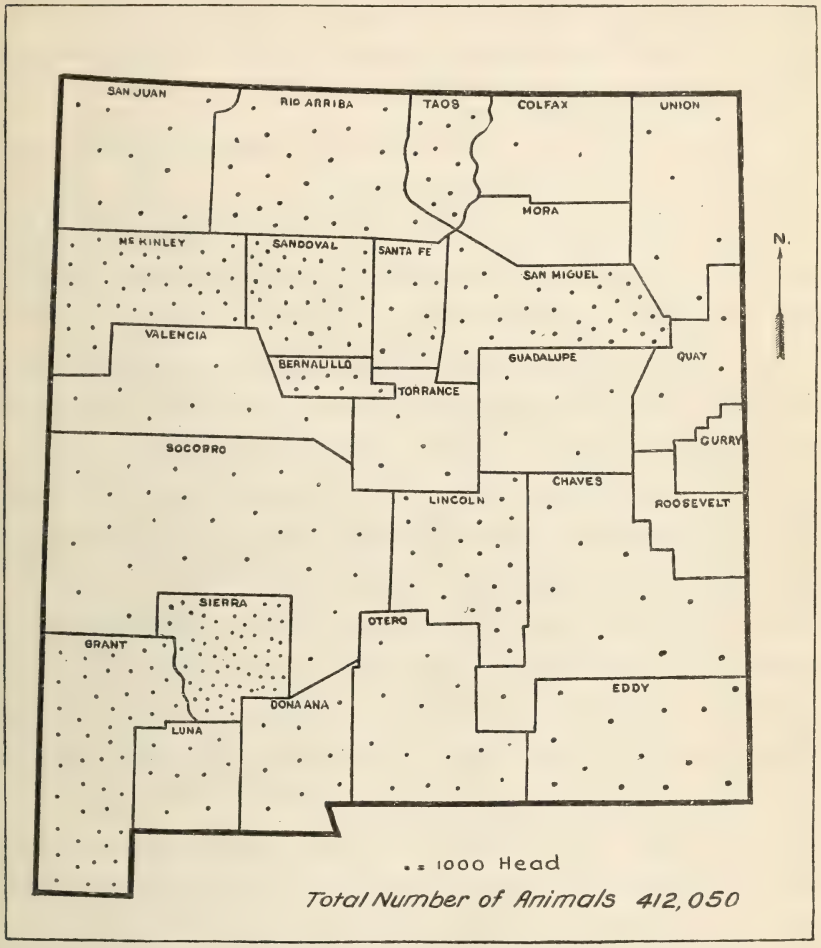

FIG. 3.—Outline map of New Mexico, showing the distribution (by counties) of goats, according to the Thirteenth Census.

LEGAL STATUS OF THE BUSINESS.

Every business must have a proper standing before the law.

There is a steadily increasing demand for beef and mutton, hides and wool, and the supplying of this demand is recognized as a legitimate business.

The cheap production of these commodities calls for the use of large bodies of low-priced lands.

New Mexico has large areas of cheap land upon which these products may be grown and which are not well suited to any other business.

Naturally they have been occupied by stockmen, but the difficulty of obtaining and maintaining control of the land has materially retarded the natural growth of the industry, and to-day this lack of legalized control of the land is not only reducing the output and rendering the business precarious, but is causing marked deterioration of the range itself, besides causing great and frequent losses of valuable property, to say nothing of the suffering of thousands of animals that die of starvation.

A careful examination into the conditions, laws, and customs now controlling the business is here attempted.

Under another heading attention has been called to the relative areas of land held under legal tenure of one kind or another. It is of importance to know how possession of the Government lands is maintained and to understand how this form of tenure affects the stock-raising industry.

It must be kept in mind that only such land to which the claimant has title or right or is in process of obtaining such title by the method prescribed by the land laws may be inclosed with a fence.[1] To this group belong (1) the patented homesteads, desert claims, timber claims, lieu-land selections, or all Government lands that have been filed upon according to some existing land law; (2) all railroad land grants which have not been exchanged for lieu-land scrip; (3) all the lands included in the old Mexican land grants that have been confirmed by the courts; (4) the State lands which have been given to the State by the National Government as an endowment for its educational, penal, and charitable institutions,[2] and (5) land held in small areas under mineral claims, such areas being held from one year to the next by performing the assessment work each year. It goes without saying that all such lands may be fenced and controlled according to the will of the claimants.

All other lands, not including various reservations like national forests, Indian reservations, etc., are Government lands and according to the rulings of the General Land Office may not be inclosed with a fence. They are public property and in the sight of the law may be used by everybody in general and nobody in particular. This situation arises as the result of lack of legislation concerning the

[1] Under certain conditions special permission to fence limited areas of Government land within the national forests may be obtained. Recently the policy of building drift fences has been to some extent adopted and is strongly recommended by the United States Forest Service. (See Graves, H. S., Report of the Forester, United States Department of Agriculture, 1912, p. 69. Washington, 1912.)

[2] This area consists of four sections in each township for the grade schools and several hundred thousand acres scattered over the State for the other institutions named.

disposal of such land. It was assumed when the existing land laws were made that all land was about equally good and that 160 acres of it was amply sufficient for the support of one man's family; that if he wanted any of it he might have that much and welcome; and that all of it would ultimately be given by the Government to its individual citizens.

It has since been learned that much of the land will not support a family upon 160 acres, but that in certain places from 20 to 50 times that area is necessary. Of course, the original lawmakers assumed such land to be desert and therefore valueless. It has a certain value as pasture land, however, and in order that its best use may be secured it is necessary that it should be used to some degree in severalty instead of in common. It being impossible to obtain legal control of it in bodies of sufficient size to carry on stock raising with profit, men were forced to control it some other way or not use it.

The need of stock water is as great as that of stock feed, and the pioneers in the stock business at once perceived that the water could be controlled. So to-day throughout the region the permanent watering places are all held under some kind of legal right, and it is through the control of the water that the range is controlled.

This set of conditions gave rise to the custom that men should use and claim as their own the pasture lands surrounding their watering places. Whenever a conflict of interests arose, the men concerned had to settle it among themselves. Community of interests and the desire for an amicable agreement have led to a set of customs that have the force of unwritten laws. These differ to some extent in different localities, mainly because of local conditions, but the basal principles, being dependent upon the requirements of the business itself, are quite uniform. The worst differences arose between the cattlemen and sheepmen, because the methods of caring for their stock are of necessity different, and hence their interests are strongly competitive instead of parallel. As long as there was plenty of unoccupied land to which the more venturesome spirits might move, severe competition was only local and sporadic, but as soon as the available range was all occupied, competition became more and more strenuous. Competition is generally not vigorous between those subdivisions of the industry of the same kind and approximately equal grade. Thus a group of small cattlemen in a region get along fairly well together, having only petty personal jealousies. Large cattlemen recognize the rights of their equals in the business.

On an open range it is, of course, necessary to have all water open, and cattle and horses go where they will to drink, though they are generally "located" in some particular region. It is the common

custom to allow all stock of whatever ownership to water at any watering place, and the man who would exclude any of his neighbors' stock from his water troughs would be ostracized. But this necessity of the business makes it possible for the stingy or thievish man to "edge in" on every other owner in his district. He "develops" water at a certain place, but not in sufficient quantity to supply the number of animals he puts upon the range. It follows that his animals get some of their water from his neighbors, and water costs money in the range country at any place. Thus, the small man is a thorn in the side, especially of the large owner who has a first-class equipment. The latter may retaliate by throwing large numbers of his stock into the small man's range long enough to eat it out in a short time, or by instituting legal proceedings on trumped-up charges, thereby causing the small man loss of time and unnecessary expenditure of money. These are but a few of the more patent of the competitive methods in use among cattlemen, and another similar set is to be found among the large and small sheepmen.

The battles between the sheep and cattle industries have been told time and again. The sheepman has the advantage in most respects. His stock are herded all the time; they can be held on any spot as long as he desires; if held long enough they will practically obliterate the vegetation on such an area; they require much less water than cattle, and with green succulent feed may go for long periods without any water at all; they may be driven in almost any place where other stock can go. He is thus able to drive over a cattleman's range and leave desolation in his wake if he wants to; and he may do this, too, without overstepping his legal rights.

For convenience in handling the sheep at night, the herders build brush corrals. These corrals burn readily after the brush is dry. When not in a corral, sheep may easily be stampeded and scattered at night. A herder's camp fire at night is a conspicuous target, but the immediate vicinity is very unsafe when rifle practice at such target is going on, and a band of sheep without a herder is soon lost. Such gentle hints as any of these may be taken to indicate to the sheepman that it is time for him to move on.

The industry is now developed to such a state that if a man wishes to enter it he must either buy a range and its rights or develop some of the few remaining unoccupied areas, where water is hard to obtain and where the supply of feed is scanty and uncertain. In either case, he must be able to invest considerable capital in the business. This means that the industry is upon a much more permanent basis and is consequently more highly organized.

Perhaps no other demand of the business is so well recognized by all those interested in it as the desirability of control of the range,

and nothing but the selfish interest of the few who are getting the lion's share under the present régime and the fear of the many that the last state might be worse than the first have for years prevented legislation.

Advantage has been taken of various methods to obtain control and to divide up the range. Natural barriers, like mountains or impassable lava flows, have always been used. Until recently, areas without water have been natural barriers, but such areas are now very rare. The railroad rights of way have been fenced and now act as drift fences. Miles of drift fence have been constructed since a ruling of the Commissioner of the General Land Office was made, deciding that such fences might be allowed to stand, since they do not inclose Government lands. The law allowing a county road to be fenced has resulted in the establishment of some very queer-looking county roads. All such fences and natural barriers have resulted in cutting up the country into large, more or less independent areas, and have given some individuals in favored localities practically complete—though not legal—control of their ranges. Such individuals have little to obtain from any legalized system of control except the necessity of paying for what they now get for nothing.

Individuals or corporations who have had the money necessary have bought lieu-land scrip and placed it on compact bodies of land or have bought such of the Mexican land grants as they could obtain title to. For years most of these grants have been treated as the United States public lands; at first, because the grants had not been confirmed in the land courts. Later, since the titles were confirmed, it has been difficult to get the authority for the management of such lands delegated to any representative of the owners, because too many claimants had to be considered. Recently, some of these grants have been sold and fenced, and others are leased in severalty without fencing, much as the national forests are treated.

Similarly, the lands given to the State and its institutions by Congress may be leased in large bodies. The practice of leasing the school section and fencing it for a pasture is a common one, and it is a not uncommon habit in places to rent a given school section and fence one or more sections that happen to be conveniently located, with scant regard for the terms of the rental contract. Land inspectors come around at very rare intervals, and even then they do not know where the township and section corners are and can not demonstrate without an expensive survey that the area fenced is not the same as that leased. Hence, the fences stand and the fenced areas increase in number and in size. Sometimes State lands have been so located as to cover natural waters, like springs and streams

in the mountains or places where wells might easily be dug. These lands have then been leased, and by this means the water and range have been controlled and possible settlers have been kept out.

A large part of the railroad lands was surrendered for lieu-land scrip. The remainder now in the possession of the railroads is rented for grazing purposes so far as possible. Practically none of these lands are fenced, because they are the alternate sections.

The grazing privilege on the national forests is controlled by a permit system that guarantees the proper use of such ranges, rendering the business less hazardous and at the same time increasing the carrying capacity.

It will thus be seen that the desire of all parties engaged in the business is some sort of legalized control of the range lands; and wherever this has been obtained and is at the same time associated with the proper kind of management, the result has been beneficial to the industry and to the range also, and consequently to the State

NATURE OF THE FORAGE CROP AND ITS DISTRIBUTION.[1]

Plains.—Much of the area of New Mexico consists of open, nearly flat stretches that pass under such names as prairies, plains, or mesas. They range in elevation from about 3,500 to nearly 7,000 feet above sea level, a few, like Johnsons Mesa, reaching 8,000 feet. Such plains are usually covered with a more or less dense covering of grasses, which in the northern part of the State forms a tolerably thick sod. (Pl. II, fig. 1.) In the southern part of the State the grass covering is always less dense and rarely, if ever, forms a true sod (Pl. III, fig. 1), while in many places the ground is absolutely bare over areas many acres in extent (Pl. III, fig. 2). Over large sections, often of many thousands of acres of these plains, the soil consists of loose sand and is covered with a more or less scattered growth of sand, bunch, and sage grasses (Pl. IV, fig. 1) or a scrub oak known as shinry (Pl. IV, fig. 2). Often the tight soils of the southern part of the State carry a growth of shrubs which are valuable browse plants, of which mesquite and shadscale (locally called sagebrush or coarse sage) are the most important. (Pl. V, fig. 1.)

Besides the grasses and shrubs already referred to, there is a long list of herbaceous annuals and perennials that appear in the growing season. The spring growth is fairly constant where some winter rain or snow may be depended upon, but in the southern part of the State these spring weeds only appear abundantly when three favorable conditions occur in sequence. There must be enough rain in the fall to germinate the seeds; the winter must be wet enough and warm enough to produce good root growth; and the spring must not be so

[1] A detailed treatment of the forage plants of New Mexico will be found in New Mexico Experiment Station Bulletins 66, 78, 81, and 87.

FIG. 1.—VIEW IN THE SOUTH-CENTRAL PART OF NEW MEXICO, SHOWING A TYPICAL AREA OF OPEN OR SCATTERED GRASSES.

FIG. 2.—VIEW IN THE SOUTHERN PART OF NEW MEXICO, SHOWING AN AREA OF PERFECTLY BARE SOIL.

FIG. 1.—VIEW IN THE SOUTHEASTERN PART OF NEW MEXICO, SHOWING GROWTH OF SAGE OR SAND GRASSES ON SANDY LAND.

FIG. 2.—VIEW IN THE SOUTHEASTERN PART OF NEW MEXICO, SHOWING THE GROWTH OF SHINRY ON SAND HILLS.

FIG. 1.—VIEW IN THE SOUTH-CENTRAL PART OF NEW MEXICO, SHOWING THE SHADSCALE AND MESQUITE ASSOCIATION OF PLANTS.

FIG. 2.—A BRUSH-COVERED AREA IN NEW MEXICO, SHOWING A SMALL SPOT HAVING AN ALMOST PURE STAND OF GRASS.

FIG. 1.—VIEW IN NEW MEXICO, SHOWING AN AREA ALMOST COMPLETELY COVERED BY SNAKEWEED AS THE RESULT OF OVERSTOCKING.

FIG. 2.—VIEW IN NEW MEXICO, SHOWING A CHARACTERISTIC GROWTH OF THE ROCKY MOUNTAIN BEE PLANT DUE TO OVERSTOCKING.

dry and windy as to dry up or cut off the young seedlings. In an experience extending over about twenty years but three such springs occurred at one point in the region mentioned. In the summer after the rains there is commonly an abundant crop of such plants.

Many of these plains are really bolsons, or basins, without a drainage outlet, and in all such low places where the water collects and evaporates, as well as in many places in the river valleys where the water table is near the surface, alkali occurs in greater or less abundance. In such places may be found an association of alkali-loving plants, many of which are usable as forage in default of something better.

Porous gravelly mesas.—In the southern part of the State are large bodies of dry, porous, gravelly soil that usually lie as bands of greater or less width paralleling the mountain chains. The dominant plants of these areas are shrubs of no forage value, and there are few forage plants of any kind in the association. The factor which in the last analysis determines the distribution of this association is probably one of soil aeration, though it may be dependent upon the amount of available water.[1]

Where wind-transported sand or loess collects under the protection of bushes, bluffs, or other obstructions, a spot of soil of an entirely different texture is formed and other plants occur. It is not uncommon to find in these bush-covered areas spots of this kind, from a few square feet to several acres in extent, upon which occurs an almost pure stand of grass. (Pl. V, fig. 2.)

Sometimes there is a good crop of annuals upon these gravelly mesas, but this crop is rarely used, since at such times there is an abundance of better feed elsewhere. These areas also are poorly supplied with watering places, because the feed will not warrant the expense. If some drought-resistant shrub having a value as forage could be found that might replace the valueless shrubs of these areas, much land now useless could be rendered productive, at least to some degree. The amount of vegetation now produced upon these areas is about the same as that upon the tight soils of the region, but it is not usable because of its kind. Hence, there is hope that a valuable plant may be found that will grow here.

Arroyos.—In most general terms, the plants that grow in the arroyos or dry watercourses are the same that grow in the foothills of the near-by mountains and have followed the drainage channel downward, or those that have followed back up these channels from the

[1] An investigation carried on at the New Mexico Agricultural College by a student assistant of the writer, Mr. O. B. Metcalfe, demonstrated pretty completely that a pronounced tension line between almost pure creosote-bush and shadscale associations was not due (as we had long believed) to a difference in alkalinity of the soils. Careful examination, chemically and physically, of the soils to a depth of 6 feet at several places across the tension line showed no differences in soil except those arising from the size of the particles. The soil upon which the creosote-bush association grew was very gravelly, and some of the bowlders contained in it were so large that it was necessary several times to dig a pit instead of using the soil auger to get the soil samples. The soil supporting the shadscale association was much more finely grained, being mostly a sandy loam at the surface and not gravelly below.

lower levels into which the arroyos debouch, with a few that have come in from the adjacent mesas or ridges.

The physical factors that determine this distribution relate in some way to local water and air drainage. While the upper courses of such arroyos are likely to be deep and full of plants, the lower reaches are usually dry, broad, flat, gravelly channels, at most but a few feet lower than the surrounding land and practically bare of vegetation or occasionally having a crop of range weeds.

Woodlands.—As used here, the term woodlands refers to those areas that are covered with a more or less scattering growth of low trees, a plant formation occupying a zone between the grass-covered plains and the forest-covered areas of the higher mountains. Typical woodlands occur on the lower parts of the mountains, ranging upward from 1,000 to 2,000 feet above the level of the surrounding plains. Where these plains are relatively low, as they are in the southern part of the State, the wooded areas begin at about 5,000 feet elevation, while farther north, where the plains are much higher, the lower limit of woodland is sometimes as high as 7,000 feet. Throughout the State the area is characterized by the presence in greater or less abundance of low scrubby trees and numerous shrubs. Among these occur various bunch grasses and numerous herbs during the growing season. This plant formation often covers the lower drier ridges and mountains to the summits, especially on the southern exposures where the zone is nearly always broad, while on the higher mountains and especially on steep northern slopes the zone is apt to be narrow or sometimes almost absent.

Forests.—Above the woodland zone in the mountains come the forests. First, as one goes upward, are the open forests of western yellow pine with interspersed parks (the transition zone), then the denser forests of pine and Douglas spruce (mainly the Canadian zone), and last the dense spruce forests (Hudsonian zone), reaching the timber line. These forests exist only because of the rainfall that occurs at these levels, and the growing conditions thus produced result in an abundant and varied flora, most of which is readily eaten by stock. As the elevation increases, the forests become denser, darker, and wetter. The growing season also is shortened, as is the grazing season, the area above the transition zone being mostly summer pasture.

Above the timber line there are some ridges and peaks which have a short-lived crop of grass, sedges, herbs, and a few low shrubs, but this area is very rarely reached by stock even in the warmest of the summer weather.

Practically all of the lands held by the Federal Government lying in the woodland zone and those above it are now administered as national forest.

UNDESIRABLE RANGE PLANTS.

Besides the useless shrubs occurring on the gravelly mesas, two other types of undesirable plants occur. These may be called for convenience range weeds and poisonous plants. Range weeds are of two kinds—native and introduced—and their presence upon the range is due to two facts: First, and of much the greater importance, because the animals will not eat these plants at all or only when forced to do so by extreme hunger; and, second, because their natural plant dominants (both biologic and economic) have been removed by overstocking.

In the main, those native plants which have become the commonest and apparently most important range weeds are not very aggressive and would not occupy the large areas they do but for the effective assistance in their struggle for existence which they receive from the animals. Yet so important has this factor of animal interference with the adjustment of plants in different associations become that large areas are often occupied by almost pure stands of plants that would normally form but an insignificant part of the vegetable covering.

The best example of this kind of a range weed is found in the snakeweed (*Gutierrezia* spp.), which also is called by its Mexican name yerba del vibora (Pl. VI, fig. 1). In many places it is called sheep weed because of its abundance on overstocked sheep ranges. So infrequent is this plant on a normal range which has not been overstocked that the average observer rarely sees it, and it has often been sent to the writer as an example of a recently introduced and very harmful weed.

In response to the oft-repeated question of how to get rid of the snakeweed, there is but one method economically possible, and that is to give the grama grass a chance and it will crowd out the snakeweed. In the eastern counties of the State, where the influx of settlers several years ago drove range stock out and gave much of what had been range land a long and much-needed rest, this very thing happened. It usually happens inside the fences of the railroad rights of way. There is little doubt also that the burning of the dead grass, a custom of the Indian days, was very destructive to the snakeweed, which is quite resinous, burns readily, and is easily killed by fire, but it did little damage to the grass except to destroy the standing dry crop. Advantage might be taken of this fact locally to hasten the eradication of this weed. Rabbit brush (*Chrysothamnus* spp.) occasionally assumes this rôle in certain localities.

Another common, though less important, weed of the open parks in the forests is the Rocky Mountain bee plant, which in places occupies large areas to the more or less complete exclusion of some of the best of the forage plants. (Pl. VI, fig. 2.)

Of more importance is a group of introduced weeds, about the probable effects of which we know less and whose spread within recent years has been rather ominous. These are mostly tumbleweeds, of which the Russian thistle (*Salsola pestifer*) is far and away the worst. (Pl. VII, fig. 1.) Their seed-distribution habits are admirably adapted to an open country with strong winds, and they scatter their abundant crops of seed over wide areas. Most of the species are able to endure extreme drought and great heat; their seeds germinate readily and the seedlings endure very unfavorable conditions and grow into plants that mature seed whether they be but a few inches high or reach maximum size. They practically all belong in the goosefoot or amaranth families and have to their credit the fact that they are all to some extent valuable as forage when young, and they are eaten when nothing better is available.

In regions having a rainfall of over 15 inches the Russian thistle is very much at home, and wherever the native grasses have been killed out either by stock or by the plow it is a pestiferous weed. For a short time, while it is young and tender, it is a fairly good feed, and it has been used as hay and silage when other crops have failed in the dry-farming regions; but these uses are always makeshift attempts to utilize a product that is not desired. Ordinarily, it does not seem to be able to crowd out the native grasses, but in the dry-farming areas, where the sod has been broken and the land deserted for any reason, it usually takes the ground completely. It also takes badly overstocked places on the ranges, especially where sheep have been held too long. Whether the native grasses will be able to crowd their way back into such areas or not still remains to be seen. If they are not, then the importance of this pest is increased many times.

Certain poisonous plants are also of some considerable menace to the ranges, especially where any overstocking is going on. Speaking very generally, these plants form a very small and numerically unimportant part of the natural flora until the factor of overstocking enters. Of course, the different species differ in importance merely on the basis of the readiness with which they reproduce themselves and their ability to compete with their plant associates. Under normal conditions, unless pressed by hunger, grazing animals of all kinds let them alone and hence do not in any way interfere with their natural rate of reproduction and spread. Like other weeds that are not eaten, they thus tend to spread much more rapidly when relieved of their plant competitors by the animals. In fact, under these circumstances there is nothing left but their animal and plant parasites to hold them in check, unless man should interfere.[1]

[1] A few species of loco weed have become so abundant on some of the sheep ranges of California that it is now the custom in certain localities for the herder to carry a spud or a spade, dig these plants up, collect them, and burn them. The practice evidently pays or it would not be followed.

FIG. 1.—VIEW IN THE NORTHWESTERN PART OF NEW MEXICO, SHOWING A TYPICAL GROWTH OF RUSSIAN THISTLE ON AN OVERGRAZED SHEEP RANGE.

FIG. 2.—A PUMPING PLANT AND RESERVOIR IN NEW MEXICO, THE WELL IN CONNECTION THEREWITH BEING 330 FEET DEEP.

FIG. 1.—VIEW IN THE NORTHERN PART OF NEW MEXICO, SHOWING THE BEGINNING OF AN ARROYO ON AN OVERSTOCKED RANGE.

FIG. 2.—VIEW IN NEW MEXICO, SHOWING THE RESULT OF A SUMMER SHOWER WHICH LASTED BUT A SHORT TIME AND ILLUSTRATING MOST CHARACTERISTICALLY THE IMPORTANCE OF THE RUN-OFF.

Whatever may be said of the undesirability of weeds on a range, there is one thing to be said in their favor. Any vegetable covering in an arid region is better than none, since such a covering prevents to some degree the removal of the soil, and any plant association occupying an area is to be looked upon as merely one stage in the production of that ultimate assemblage of plants which is best adapted to that place and its conditions.

EROSION.

To the observer from a humid climate, perhaps no one characteristic of the arid regions of the Southwest is so startling as the evidence on all sides of the forceful action of water as an erosive agent. And this in a land where water is the one thing that is everywhere lacking.

But the reason is patent after a summer in the region, and the conditions are common to all arid countries of high relief. The erosive effects that one sees so plainly are the resultant of several factors. During the warm weather, the only season of the year in which large volumes of moist air are brought into the region, the air next the ground is always warm and therefore relatively dry. Hence, rain occurs only when masses of humid air are forced into the cold upper strata. Such conditions arise only locally and produce showers of restricted size, but such showers are mostly torrential in character, a large amount of water falling on a restricted area in a very short time.

Let such a downpour occur on what seems to be a flat plain, and in a few minutes the lower levels are flooded and the roadbed of any obstructing railroad is apt to suffer severely. Thus, we are forever hearing of railroad washouts in a region that is called a desert and is wanting governmental irrigation systems established. (Pl. VIII, fig. 2.)

The land is but sparsely covered with any kind of vegetation and there is little to obstruct the run-off. The gradient is high at almost any place. Add to this the fact that the soil has been loosened by daily expansion and nightly contraction, due to large diurnal variations of temperature, and the conditions for maximum efficiency of the erosive agent are supplied; and the consequences are not only not singular but were to be expected instead of wondered at.

The factor which more than anything else tends to prevent the same kind of results in a humid region on an even larger scale is the protective cover of vegetation everywhere abundant, and no one factor is so efficacious in producing rapid erosion on the arid grazing lands as the more or less complete removal of their already scanty cover of plants by overstocking.

A common sight on an overstocked range is the arroyo made by the run-off which has not been held back by the grass and bushes until the water could soak into the ground. (Pl. VIII, fig. 1.) So the removal of even the grass and low shrubbery results in the partial loss of the soil and much of the ground water.

These effects, like many others of the range country, are cumulative. Once a cut is started it soon becomes a trench into which the water drains, the soil is gradually all carried away and in the end nothing is left but the gravel and bowlder-strewn channel where little or nothing can grow. Many of the ranges in New Mexico that years ago were gently rolling grass-covered plains are to-day cut and scarred by arroyos that are almost impassable to a horseman, and all because the region has been overstocked.

RANGE MANAGEMENT.[1]

As stated in another place, in New Mexico to-day the stockman usually owns the land upon which he has "developed" water, and he is warranted by the custom of the country in the use of the range half way from his last watering place to the nearest water of his nearest neighbor, on all sides. He must maintain at his watering place a supply sufficient for the number of stock he may have watering at that place. Such watering places must be open to all stock that come to them of their own volition. Only animals which are driven through the country are expected to have their water paid for, and this recognizedly legitimate charge is often not exacted.

The stockmen's wars, so common a number of years ago, are mostly of the past, for everybody concerned has learned that such methods do not pay. There is still more or less friction among individuals in a small way, as they overreach or are overreached. But in general there is a desire to play fair, or at least within what are recognized as the "rules of the game." What is needed for the improvement of the business is a pronounced change in the rules.

The routine work of the ordinary cattle ranch of to-day consists in maintaining the watering places, moving stock from one place to another as the feed varies, looking after old cows or dogy calves, riding bog, and going after strays, with the heavy work of the spring and fall round-ups, and the incidental branding of calves that have been missed. Owing to the fact that the cattle are in no way restricted in their movements and that all distances which must be traversed are large, such work requires much riding by a number of men, depending upon the size of the ranch.

[1] The word management as used in this bulletin in every case means the financially profitable regulation of the individual enterprise considered as a productive business unit. The principles apply as well to the man with a hundred or so cattle or horses or a single band of sheep as they do to the owner of thousands of animals and large equipment.

With sheep there is the continual round of driving to the feeding grounds in the day and back to the bed grounds at night, with a trip to water every few days, depending upon the kind of feed and amount of water available. The camping place must be changed at frequent intervals, and there is the eternal hunt for good feed. There must be persistent care to prevent the splitting of the herd or losing a bunch of stragglers, and to keep predatory animals out of the flock; and in the spring comes lambing, shearing, and dipping, though in some places shearing is done twice and dipping may also have to be repeated. Most of such work must be done on foot and always in the open, whatever the weather.

When the dry seasons come there is work for all and a hard time for the animals. Though all the stockmen know that the dry seasons will surely come, there is at present little chance of making any preparation for them.

The ideal toward which the individual stockman must always strive is to manage the factors under his control so as to produce upon his range the largest and most valuable crop of forage that it is able to maintain season after season under use, and the adjustment of the proper number of animals to the ranch needs excellent judgment in order to get the best returns. In the opinion of the writer, considerable of the overstocking now done on controlled ranges is due to a lack of accurate knowledge of their carrying capacity, which results in poor judgment in making the adjustment mentioned.

Everybody knows in a general way that there are already too many animals on the range under the present form of management. Many of the more thoughtful stockmen know that it would pay them to reduce the number of stock on their ranches and give the grass a chance to grow, but there are always new men coming into any range country who do not know the rate of feed production of the region. Such men recognize the possibility of developing water in favorable positions, and if they find grass in any quantity which is apparently not being used, they think they have found the place they are looking for. If Mr. A, who has been in possession of that region for maybe twenty years and who does know what the region will carry, complains to the newcomer that the latter is crowding in where there is no place for his stock, Mr. A has absolutely no means of convincing the new arrival of either his knowledge or his sincerity.

The land is all open to entry. The new man can take up a claim and develop the necessary water and turn his stock on the open range, and no one can prevent him. Nor can anyone either protect Mr. A in his claims or insist that only so much stock shall run on a given area. If the seasons are good for a year or so, the range may carry the additional stock, and the newcomer is sure he was right, but when the dry years come both men are bound to lose heavily.

It does no good then for Mr. A to say "I told you so," and his only hope is that he can endure the losses longer than the new man and that the latter will be forced to leave.

There are only two other things that Mr. A can do. He may either buy the newcomer out and so get rid of him—a practice that sometimes induces men to dig wells to sell to established stockmen who have made money—or he may develop another watering place near the newcomer, thus restricting the latter's range to a minimum, and wait for the dry years. Any way that the matter may now be adjusted ultimately results in a direct loss for both men (accompanied by great suffering by the stock), an indirect loss to the general business interests of the region, and a serious depreciation in the value of the range.

An experienced and successful cattleman in the southern part of New Mexico, commenting to the writer on this state of affairs not long ago, said:

> I can better afford to take the $2,500 loss of stock which I know I will have when the dry years come than to take my stock off my range and try to save the grass which I know I will need in those dry years. I hold my range now only by having my stock on it. If I take my stock off, someone else will take my range, and I can afford to lose the stock better than lose the range.

Every stockman using Government range lands is forced into this kind of action whether he be astute enough to have reasoned it out or not. Yet these same lands under a better type of management (possible only under legalized control) would carry safely all the time more and better stock than they now carry with such uncertainty.

Now the crux of the situation is expressed in the phrase "possible only under legalized control." The mere fact that the stockman is not able to protect his range against willful misuse by himself is the best of evidence that the industry has reached the limit of its possible development under the system of management now in operation. The earlier growth of the industry occurred under a condition of what was practically unlimited free range and was satisfactory in most ways as long as this condition continued; but as soon as all the range land was occupied a new system became necessary, and this necessity has been seen by investigators and far-sighted stockmen for a long time. Before the industry can develop further it must become possible to determine how many animals may be put on a given area. But control of such animals as cattle, horses, mules, and burros can be maintained only by fences. Under the present system sheep and goats *can* be managed so as to prevent overstocking, but they rarely are. With a properly fenced range even they are better off, and the range is also. Let us assume that the right to fence the range lands in severalty has been obtained and consider the changes in management rendered possible thereby.

The necessity of allowing feed to mature.—It is a well-known botanical fact that in order for ordinary green plants to grow they must have leaves, since the food from which new growth is made is elaborated mostly in the leaves. This point has been emphasized by various writers, but no definite data as to the exact effect of pasturage upon the quantity of feed produced have been obtained till recently. Studies carried on by Drs. Briggs and Shantz have given some very definite data for alfalfa. From their work it appears probable that whenever range land is closely pastured during the growing season its total productivity is automatically reduced approximately two-thirds, or possibly more. Or, stated generally, close grazing during the growing season reduces the carrying capacity about two-thirds.

One way to diminish this effect is to divide the range into a number of relatively small pastures and give each pasture a rest in turn. Each pasture must be given as long a time to grow its crop as is possible, keeping in mind all the time the fact that the stock must grow as rapidly as possible. It is probably better to put a large number of animals on a relatively small acreage for a short time, thus giving the plants a long period of growth. This procedure makes a larger number of watering places necessary.

The utilization of summer feed.—Subdividing the range is beneficial in another way. In many places there are areas that produce forage which is good feed only while it is green. On other near-by areas forage which cures standing occurs. The latter is the natural winter feed of the region, but these plants are usually preferred by animals while they are green. Thus, if the animals are allowed to range freely and select their feed they eat the winter feed in the summer time. From the standpoint of sustenance the summer feed is all right in the summer, but poor in the winter. Hence, good management requires that it be eaten while at its best. Similarly, the winter feed should be saved till the winter time. Without fences such management is impossible, and the selective action of the stock is always operating to destroy the best feed on the range, for they always graze it more closely, even when the range is properly stocked.

In the higher mountain country some of the range is available only in the summer, because it is covered with snow in the winter. There is some tendency for free-ranging stock to go to the higher levels in the summer, which is advantageous to the stockman. While cattle will climb the hills if they have to, they will congregate in the open valleys and parks as long as the feed lasts, unless they are fenced out. But the valleys and parks may be pastured earlier and later than the mountain sides and should be fenced. Many such treeless areas are capable of cultivation or may be turned into meadows where a good crop of hay may be grown.

Thus in a number of ways the ability to subdivide the range into pastures makes a much more effective utilization of the forage crops possible and so increases the carrying capacity.

The importance of reserve feed.—Attention has been called to the variability of the climate of the region. It is as safe to prophesy lean years in New Mexico as it was in Egypt in Joseph's time, and they usually come in cycles of two or more seasons in which the precipitation is below the average. Only two ways of adjusting the stock business to these years of scanty growth are possible. One must either reduce the number of stock or be able to fall back on a reserve supply of feed. The forced sale of the stock nearly always means financial loss, largely because of the condition of the stock. They have been held in expectation that the rain will occur at what is generally referred to as the usual time. The stock at this time have just passed the season of poor feed and are not in first-class condition for sale, and the longer the rain is delayed the poorer and less valuable they become. If the owner sells at this time, he is bound to lose heavily. Yet, if the rain does come even late in the summer, growth is so rapid that there will be feed enough to carry over to what may be a better year. So he hopes and holds on. But if rain does not come at all, the weak stock and many of the young will die. Thus a large percentage of the breeding stock is lost and the next year's crop much reduced. On much of the New Mexico range country two or three such seasons in succession will put many of the stockmen out of business and kill thousands of animals. Yet these cycles of dry seasons come, and everyone knows they will come again, but no one can get ready for them, because he can not fence his range.

Developing water.—Attention has already been called to the fact that the control of the range is now maintained by the control of the stock water. Of course, it must be understood that wherever there is sufficient water for irrigation purposes it is always so used. In New Mexico there is almost everywhere sufficient stock water to supply all the animals which the range will carry, and in many places quite a little more could be developed. This is one of the factors which have made overstocking not only possible but unavoidable under the present system of tenure.

Wherever there is underground water within 500 feet of the surface, the earth tank and cased well, with its big windmill and gasoline engine, furnish a supply that can be depended upon. (Pl. VII, fig. 2.) Such equipment is, however, the sign of the investment of considerable money; the deeper the well, the larger the expense, and likewise the greater the cost of use and maintenance.

Springs and small streams are always used, unless the supply is large enough for irrigation purposes. Just in the edge of the foothills, where the flood-water channels open out upon the flats, sites may

be found where a small earth dam and a proper spillway will make a tank that will catch and hold a large quantity of water. (Pl. IX, fig. 1.) These tanks are usually not very expensive, and, notwithstanding the high rate of evaporation, water is often maintained in such tanks throughout the year. The deeper the tank in proportion to its area the smaller the relative amount of loss by evaporation. Even in the plains country there is always sufficient run-off to collect large quantities of water in tanks properly located. (Pl. IX, fig. 2.) A little judgment in the selection of a site and the use of some plows and scrapers are all that is necessary to develop a valuable supply.

In the mountainous country it is frequently very easy to make lakes of considerable size by deflecting the flow of the smaller streams into natural basins, where a small dam will make a lake several acres in extent. The construction of such lakes is one of the best things that can be done upon a ranch, since all such bodies of water help to regulate the run-off. They always afford a supply of water for stock, and they frequently change intermittent streams into permanent ones, thus distributing the water so that the stock do not need to congregate. They thus reduce the run-off and tend to remove the main cause of trail making, both of which factors are very potent in reducing erosion.

No other one factor is so important as the abundance of good, clean water, well distributed over the ranch, and there are relatively few ranches that now have the water so well distributed that the range may be uniformly grazed. Stock mostly have to go too far for water, with the result that much grass is trampled out around the watering places, and the range is apt to be cut up by trails that ultimately become arroyos. And it is equally true that much more water could be developed upon most ranges, a procedure that would materially help the business. But under the present uncertainty of tenure of the range lands such expenditures are not warranted.

Reducing the effects of erosion.—There are two ways by which the effects of erosion may be reduced. Attention has already been called to the regulation of the run-off and the making of trails. What is necessary on many ranches to-day is the repair of arroyos already made. The aggregate area of land that now produces no forage as the result of the erosive action of water is large. More or less intricate systems of drainage channels have been established where formerly there was but gently rolling country with no definite channels. The original condition existed because the plant cover of the soil prevented the water from collecting into streams. The run-off occurred mostly as a thin sheet of water gently moving over all slopes, the motion being so slow as to allow most of it to soak into the soil. This is the best possible condition for the conservation of both the

moisture and the soil, as well as for the maximum production of forage, and it should be brought about wherever possible.

All arroyos should be gradually filled. This can not be done economically except very slowly and by letting the water do it. The cutting occurs because of the velocity of the water, which depends upon the quantity of water and the slope of the land. It is necessary to begin work at the heads of such channels, deflect the water from the main channels, and cause it to run over the more gently sloping land as a sheet. Large obstructions across deep ditches or gullies are of little value unless they are so strong as to hold all the water which can collect behind them, as in a tank or lake.

The same is, of course, true of the broader channels, where more extensive dams would be necessary. If such dams were built and should burst, much greater damage would be done, because of the large volume of water stored before the obstruction gave way. Small obstructions which allow a small quantity of soil to collect behind them upon which the grass may grow are of great advantage in channels, provided most of the flood waters can be kept out of the channel by deflection at the head.

All permanent lakes or tanks become local levels below which cutting can not occur in the drainage basin above them and are, of course, desirable.

The general principle to be kept in mind is that the transporting power of water varies as the sixth power of its velocity. In other words, if the velocity of a stream be doubled, the weight of the largest particles it will push along is 64 times as great as that of the stream at the original velocity. But the velocity increases with the depth and with the gradient. The importance of inducing the water to flow slowly over the surface as a thin sheet is thus apparent. And a relatively small amount of work properly applied will produce important results in restoring to productivity land which is now only used to carry away water that should go into the ground. But none of this improvement work will be done until the worker knows he will be allowed to reap the benefit of his labor.

Reseeding operations.—So far, experiments attempting to reseed artificially the ranges of most of New Mexico have resulted negatively. There are good reasons for this, to which we wish to call attention. There are, however, large areas where artificial reseeding will prove successful. Many high mountain valleys that receive considerable water, but have a short, cool season, can be set in timothy or redtop. Orchard grass, tall fescue, or brome-grass will grow in many localities if properly treated. Oats, barley, and wheat are already grown in many of the open parks of the higher mountain timbered lands, and much of the plains country of the eastern side of the State will grow kafir, milo, or some of the other sorghums. Such lands are range lands

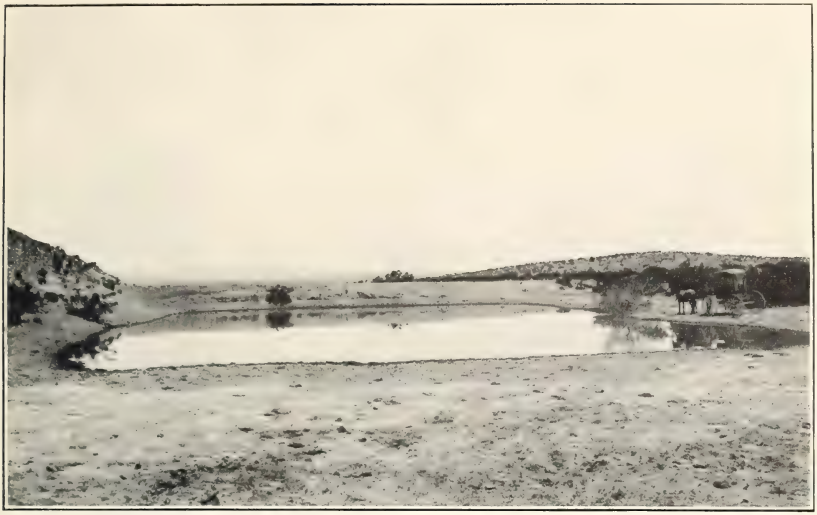

FIG. 1.—VIEW IN THE SOUTH-CENTRAL PART OF NEW MEXICO, SHOWING A SMALL TANK IN THE FOOTHILLS.

FIG. 2.—VIEW IN THE SOUTHEASTERN PART OF NEW MEXICO, SHOWING A LARGE TANK ON THE PLAINS.

only temporarily, until their owners learn that they can produce much more feed per acre by cultivating them, when they become agricultural lands, and it is no longer an experiment to try to cultivate such lands.

The commonly cultivated pasture grasses will not grow on much the larger part of the lands of the State, because of insufficient moisture, and these are the only pasture grasses whose seeds can be had in quantity from dealers. There is little doubt that it would pay to sow grama-grass seed over large areas of the range lands if good seed could be had in quantity at a reasonable price, and this same statement is true of several other valuable native grasses. But such seed can not be bought in quantity at any price. Hence, the main reseeding method is that of allowing the plants to reseed themselves. This necessitates the protection of the seeding plants till the mature seeds are distributed. The process is very slow at the start if the range is badly eaten out, for relatively few viable seeds are then produced, and germination conditions are rarely ever good even for the native plants. But this method of improvement is, like all the others so far mentioned, dependent upon the control of the land and the ability to keep the stock off during the growing season.

The control of stock.—Much of what has already been said in favor of legalized range control has assumed the regulation of the number of head of animals that may be allowed to graze on a given area. The point of view, however, in each case has been that of advantage in the production, preservation, or utilization of feed.

Of equal importance in the management of any range is the control of stock, i. e., the possibility of knowing where any given animal may be found at any time. It is much easier to maintain a watch over cattle and horses by "riding fence" than by "riding range." It takes fewer men and fewer horses, and the information obtained as to the condition of the stock is much more accurate. If a hundred cows are put into a given pasture [1] it is only necessary to ride around the fence to know whether any animals have broken in or out. One merely needs to ride to the watering place at the proper time of day to find a particular animal. Very rarely, indeed, must strays be hunted, and bog holes may generally be fenced in, the danger being thus removed.

Even though the pasture be many square miles in extent, it will take only a few men to gather all the animals that are in it if the country is open as is the case with most of New Mexico; and if the number of head in the pasture is known, the number of head gathered shows the efficiency of the men and makes it possible to ascertain the amount and causes of all losses.

[1] It must be remembered that this word is stretched from its ordinary usage so as to include areas that may be many sections in extent instead of a few acres.

With a fenced range, the spring and fall round-ups become merely the gathering of the stock in the separate pastures and can be done by a few men. The operations on each ranch thus become independent of each other and are not subject to a time schedule that may be inconvenient. The need of extra help is not so pressing. The branding can be done at the corral, where a "squeezer" obviates the necessity of running, roping, and throwing the animals, with the consequent losses that attend this method, losses that range all the way from the effects of overheating the horses and cattle to the killing of an occasional animal. Working at the corral often obviates the necessity of the round-up wagon, with its attendant expenses. To summarize: The fencing of a range and its division into separate pastures reduces the operative force necessary to handle a given area and makes the work itself easier for the men and not so hard on the stock.

The control of breeding operations.—Probably the most important function of a fence on a cattle or horse ranch is the control that it gives to the breeding operations. All stockmen recognize the importance of producing only well-bred animals, but this can be done on an open range only by the enforcement of laws controlling the character of males that are allowed at large. Considerable has been done in this respect in New Mexico as regards bulls, and the manner of handling sheep gives control of the bucks. There is at present but poor control of stallions and burros. Even with good laws there is great difficulty in their enforcement, since opinions differ very much as to what is a desirable animal for breeding purposes. Many of the men, for pecuniary reasons, especially if their means are limited, do not see how they can afford to buy well-bred animals for their small ranches, so they allow grade bulls to run and all their neighbors must put up with the consequences. One of the commonest complaints of the progressive owner is that his neighbors do not buy good bulls or enough of them. This is one of the exasperating losses which the larger single owners and practically all of the big companies have to endure under the present system. Yet all stockmen know that the practice is economically a bad one.

It is probably desirable upon some of the ranches in the higher mountains to restrict the breeding to certain months in the year, in order to avoid the losses resulting from the birth of calves during the cold weather. This plan has been tried in a few places; and while the percentage of calves dropped is smaller, the losses are noticeably less, and the total calf crop is about the same, with some advantage in favor of the practice because of the strength of the calves. With the proper precautions taken as to the number and distribution of bulls, it is likely that the percentage of dry cows could be reduced to the normal for the open range, even under this system.

Fenced inclosures also make possible the classification of the stock. The steers may be taken out of the cow herd, thereby increasing to some degree the fecundity. Young animals may be kept in pastures containing only their own kind. Uniformity in the grading of the animals makes them more attractive and more easily salable when the buyer is inspecting them. It makes possible the weaning of the calves at the proper age, which allows their mothers to recover flesh while carrying their young.

Quarantine and disease eradication.—The importance of a fence for use in the control and eradication of various diseases that attack range animals is excellently set forth in a petition [1] recently presented to the President of the United States by those residents of southeastern New Mexico who are either directly or indirectly interested in stock raising. It reads as follows:

In addition to what has been said herein as to the manifest advantages of the individual control of the range, it should be remembered that the splendid work which has for the past twelve years been carried on by the Bureau of Animal Industry would be *very greatly* facilitated. The officials of this department have done excellent and efficient work in clearing this part of New Mexico of various infectious diseases to which cattle and sheep are subject; but they have been greatly hampered and their work delayed and made infinitely more expensive and difficult by the fact that there has been no method whatever of isolating such infected herds as graze on the public domain. It is practically impossible to thoroughly eradicate even the least virulent of these diseases, such as scabies, pleuro-pneumonia, and anthrax, as long as the diseased animals can not be permanently isolated from the healthy ones, which, with herds running at large, is impossible. If under the present conditions of the range such an infection as foot-and-mouth disease, which has appeared twice in the United States in the past twelve years, should become distributed, the cattle industry would be practically annihilated. It has been fully demonstrated in this and other districts that where animals were under control in privately owned pastures, the eradication of disease has been entirely practicable, while at the same time in contiguous open ranges vast herds have perished as a result of these diseases, and their owners have been practically ruined.

Feeding range stock.—Very little feeding of range stock has been done in New Mexico for any purpose whatever, and it is still a common practice to let animals die of starvation if there is not sufficient feed on the range to maintain them. Aside from the humanitarian argument, this is really very poor business, with meat at its present price.

Within the past decade a considerable area of the State has come into cultivation by the development of various irrigation enterprises or by dry-farming methods. In consequence, a much greater area of land, previously some of the best grazing land of the State, has ceased temporarily to be used for this purpose; but in all the dry-farming area (where at present less than half the land is occupied,

[1] Written by ex-Governor Hagerman, of New Mexico.

and a still smaller acreage is cultivated) the important cultivated crops are forage crops, much of which will not admit of shipment, on account of their bulk as compared with their value. They must, therefore, be used near the place of production. Any concentrated feeds produced may seek an outside market, and the production of such feed within the State, where a large quantity of such feed should be used to carry animals over the periods of scarcity, is advantageous in many ways. The producers need a market; the stockmen need cheap feed; the railroads need the haul; the State needs the industries; and the country needs the meat.

There is little doubt that the areas into which the homesteaders have been coming for some time, and which thereby have produced much less meat for a number of years, will in the end produce much more than they originally did, unless some marked improvement is made in agricultural operations with a limited supply of water. Kafir, milo, or some other sorghum and the silo, with stock raising or dairying, seem to be one solution of the problem of living in these regions. The experience of the stockmen in other States indicates that cattlemen and sheepmen alike can very well afford to feed grain to their stock during periods of shortage of range feed.

Sheepmen are accustomed to assume that all of these generalizations that apply so patently to cattle do not affect their business. But this is not correct. It has been shown by experiment [1] that even in the heart of the forest in the high mountains, where predatory animals are most numerous and active, half of a band of sheep protected by a fence and a hunter with dogs produced more mutton and more wool and left the pasture in better shape than the other half of the band under the ordinary care given by herding. Nor is this all.

Many of the flockmasters of southwestern Texas are building fences that, with the aid of proper dogs, will protect their sheep from coyotes and wolves. This is being done because the herders of the region are becoming less reliable and at the same time more expensive. When that region is once cut up by fences into pastures of a few sections each, the coyotes and wolves can be exterminated. The cost of construction and maintenance of the fence and of keeping down the jack rabbits is the main expense which must be met in lieu of the wages and subsistence of the herders and camp tenders necessary when the sheep are handled on an open range; and the increased carrying capacity of the range, the increased amount and quality of the wool, and the increased quantity of mutton produced must be taken into account when comparisons are made.

[1] Jardine, J. T., and Coville, F. V. Preliminary report on grazing experiments in a coyote-proof pasture. U. S. Dept. Agr., Forest Serv. Circ. 156, 32 p., 2 fig. 1908.

CHARACTER OF THE PRESENT OPPOSITION TO CONTROL.

What are the interests opposed to legalized control of the range country? There are at least two that are more or less actively opposed to the idea. They are those owners who, by the nature of their stock and the region they are in, are able to get a lion's share of the benefits to be derived from the business, or they are those who, by the particularly favorable location of the ranges they now occupy, already have practical control and would only increase their expenses by gaining a legalized control. There are only a few such owners in New Mexico. But there are many who are afraid that any change which might be made would result in loss to themselves. They want control, but are passively obstructing any move tending toward that end, because they fear that in any new adjustment they would lose part or all of what they now claim.

There is nothing to criticize in any of these attitudes, since they are those of all competitive business. Each stockman is merely getting all he can out of his business under the conditions in which he finds himself, and he is warranted in so doing so long as he breaks no existing laws. But would it not be much better business to get some sort of legalized control system established which would do away with the present uncertainties and losses and make a better type of management possible?

The industry would be placed upon a much better footing. Its returns would be much more certain and could be calculated in advance with much greater accuracy. By virtue of this certainty a more complex and more remunerative type of business could be developed, which would result in an output both larger in quantity and better in quality. Hence the business would be more remunerative to those engaged in it and would improve the general business status of the State. From the standpoint of the great majority of the stockmen of New Mexico there is everything to gain and almost nothing to lose by the establishment of a system which will allow them to fence their lands and hold them in severalty, while from the standpoint of the business the promise of improvement is slight, if any (due mainly to the increased prices of the meat produced), with all the factors tending toward a diminution of productivity so long as the present form of tenure is the only one possible.

SUMMARY.

(1) The present status of the stock-raising industry in New Mexico is but one phase of the adjustment of the various industries of the State among themselves and to the physical environment.

(2) The topographic, climatic, and soil characters of the State restrict by far the greater part of its total area to the business of stock raising so long as the present agricultural methods continue.

(3) While much of the land is held under one form of tenure or another, over 31,000,000 acres, although in continuous use, now lack legal control.

(4) From the best statistics available it is shown that the stock-raising industry in New Mexico pays taxes on almost one-fourth of the total assessed valuation of the property of the State and is probably the most productive industry in the State.

(5) The present method of controlling the Government lands depends upon the legal control of the stock water and a custom which has the force of an unwritten law. This condition has arisen from lack of legislation which takes all the conditions into consideration. No type of legislation is here recommended, because it would be out of place; but that some type of legal control is not only desirable but very necessary for the further development of the industry is forcibly urged.

(6) The nature of the forage crops and their distribution are indicated in this bulletin in general terms, as are some of the undesirable plants, and methods of eradicating the latter are suggested.

(7) The management of the controlled range is contrasted with that now possible. It is shown that the present form of control can result in nothing but overstocking. Closely cropped range plants produce probably not more than one-third as much forage as when they are allowed to mature before being grazed. Feed which is good only in the summer, either by virtue of its kind or its position, can be properly utilized only on a controlled range. The more or less regular recurrence of cycles of dry years makes the reservation of feed necessary. This is rarely, if ever, possible on an open range. The distribution of stock water is to-day poor when considered from the standpoint of the demands of the business. Much could be done to improve this condition, but the necessary expenditure is not warranted while the right of control is so uncertain. Much damage has been done to the ranges by erosion. Efforts to correct this condition and to stop the consequent losses to the range and industry are not warranted so long as a man may not know that he is to profit by his effort. Reseeding operations will pay in some places, but the effort and expense are not warranted without the guaranty of returns. Fencing gives more complete control of stock and reduces the expense of operation in many ways. It allows a better organization of the business and makes the reduction of losses and increase of output possible. It also makes the improvement of the quality of the stock possible by giving control of the breeding operations. It renders the classification and grading of the animals feasible, thereby tending to increase salability. Protection from and eradication of diseases and all types of quarantine operations are much more easily applied to inclosed areas, and some of the more desirable operations are impossible on an

open range. Feeding stock in times of scarcity of range feed is indicated even under the present system of management, but this very desirable improvement can hardly be expected to occur till a better form of land tenure is guaranteed.

(8) The opposition to some legalized system of control is to-day more a passive than an active one and is due mostly to a fear of quite uncertain and indefinite possible, but not probable, consequences. There is every reason to expect that, whatever the system, those in possession of the range would be given legal control of the land they occupied at the time the system went into effect, assuming that they complied with the requirements.

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
15 CENTS PER COPY

▽